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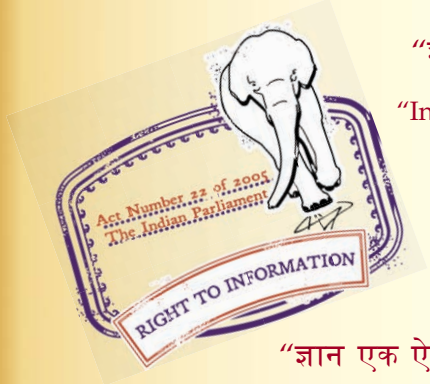

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(First Revision)

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SPECIFICATION FOR THERMAL EVALUATION AND CLASSIFICATION OF ELECTRICAL INSULATION

(First Revision)

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SPECIFICATION FOR THERMAL EVALUATION AND CLASSIFICATION OF ELECTRICAL INSULATION

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 7 August 1985, after the draft finalized by the Solid Electrical Insulating Materials Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard was first published in 1958. Its revision was undertaken to bring it in line with the latest IEC Publication 85 (1984).

0.3 In this revision, the classification of temperatures has been retained and these temperatures apply both to insulating materials (and simple combinations) and insulation systems.

0.4 This revision does not include any material as was given in Table 1 of its earlier version.

0.5 This revision does not relate to the definitions of classes to specific materials as has been the case. In the field of electrical insulation, no general classification of materials or systems according to generic type or chemical identity is justified. Alternative approaches, such as compilation of data for insulating materials according to IS : 8504* are being considered.

0.6 This revision gives basic guidance and makes it clear that the technocrats following this guidance are responsible for preparing the particular requirements for insulating materials and insulation systems used in their products. These technocrats shall make use of appropriate standards prepared by ISI.

0.7 In the preparation of this standard, assistance has been derived from IEC Publication 85 (1984) 'Thermal evaluation and classification of

*Guide for determination of thermal endurance properties of electrical insulating materials (in 2 parts).

electrical insulation' issued by the International Electrotechnical Commission (IEC).

1. SCOPE

1.1 This standard describes the recognized system of thermal classes for the insulation of electrotechnical products. It considers the thermal evaluation of insulating materials, insulation systems, their inter-relationship and the influence of service conditions. It defines the responsibility for assigning thermal identification and classification.

2. GENERAL

2.1 Ageing Factors — The endurance of the insulation of electrotechnical products is affected by many factors, such as temperature, electrical and mechanical stresses, vibration, deleterious atmospheres and chemicals, moisture, dirt and radiation.

2.2 Thermal Classes — As the temperature in electrotechnical products the temperature is very often the dominating ageing factor of influence on insulating materials and insulation systems, certain basic thermal classes to which products are produced have been proved useful and accepted throughout the world. These thermal classes and the temperatures assigned to them are as follows:

Thermal Class	*Temperature* °C
Y	90
A	105
E	120
B	130
F	155
H	180
200	200
220	220
250	250

Temperatures over 250°C should increase by 25°C intervals starting from 250°C.

NOTE — The old class C which was used in earlier version for all temperatures above 180°C is replaced by the above.

The use of the letters is not mandatory. However, the above relationship between letters and temperatures should be adhered to. If the contents of **2.2.5** are applied to particular equipment, alternative systems of identification may be used.

When a thermal class describes an electrotechnical product it normally repsesents the maximum temperature appropriate to that product under rated load and other conditions. Thus, the insulation subjected to the maximum temperature will need to have a thermal capability at least equal to the temperature associated with the thermal class of the product (*see* **2.2.2**).

Heretofore the term 'Class' has been used to refer to insulating materials, insulation systems and products IS : 8500* has introduced the term 'Temperature Index' for insulating materials, while IS : 11182 (Part 1)-1984† has introduced the term 'Identification' for insulation systems. The identification of systems is relevant only to the particular product for which the system is designed. The term 'Classification' may be reserved for electrotechnical product.

2.2.1 *Operating Conditions* — Experience has proved that, under usual operating conditions, satisfactory economic life is obtained for electrotechnical products such as rotating machines or transformers designed and built in accordance with standards based on the temperatures in making due allowance for factors peculiar to the product in question.

2.2.2 *Insulating Materials in Insulation Systems* — The description of an electrotechnical product as being of a particular thermal class does not mean, and must not be taken to imply that each insulation material used in its construction is of the same thermal capability.

The temperature limit for an insulation system may not be directly related to the thermal capability of the individual materials included in it. In the system, the thermal performance of insulating materials may be improved by the protective character of the materials but decrease the appropriate temperature limit of the system below that for the individual materials. Such problems should be investigated by functional tests.

2.2.3 *Temperature and Temperature Rise* — The temperatures quoted in this standard are the actual temperatures of the insulation and not temperature rises of the electrotechnical product.

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*Guide for determination of thermal endurance properties of electrical insulating materials.

†Guide for evaluation of insulation systems of electrical equipment: Part 1 Identification, evaluation and ageing mechanisms.

Standards for electrical equipment usually specify temperature rise rather than actual temperature. In estabilishing such standards, factors such as features of construction, thermal conductivity and thickness of insulation, accessibility of insulated parts, methods of ventilation, load characteristics, etc, should be taken into account when considering the methods of measurement and the temperature rise to be permitted.

2.2.4 *Other Factors of Influence* — Apart from thermal factors, the ability of insulation to continue to fulfil its function is influenced by such conditions as mechanical stresses imposed upon it and its supporting structure, and by such factors as vibration and differential thermal expansion which may become of increasing importance as the size of the product increases. Moisture in the atmosphere and the presence of dirt, chemicals, or other contaminants may have injurious effects. All such factors should be taken into account when designing particular products and further guidance on this aspect may be found in IS : 11182 (Part 1)-1984*.

2.2.5 *Insulation Performance*

Actual performance in service depends on particular conditions, which may vary widely with environmental exposure, duty cycles and type of product. Further, the intended performance in service varies greatly depending on the relative importance of size, reliability, desired period of use of associated equipment, and economic considerations.

For certain products it may be desirable to establish values of temperature rise which permit temperatures higher than those normally appropriate or which restrict the temperature attained by the insulation to values lower than those normally appropriate. Such cases may arise because, for the purpose in question, a shorter or a longer life than normal is envisaged, or exceptional conditions of service exist.

The life of insulation is dependent to a considerable extent upon the degree of exclusion of oxygen, moisture, dirt and chemicals. Therefore, at a given temperature, the life of the insulation may be longer if it is suitably protected than if it is freely exposed to industrial atmospheres. The use of chemically inert gases, or liquids, as cooling or protective media may increase the temperature capability of insulation.

In addition to the ageing which insulation undergoes, some materials when heated above a certain temperature, soften and otherwise degrade but may recover their initial properties again in cooling. The

*Guide for determination of insulation systems of electrical equipment: Part 1 Identification, evaluation and ageing mechanisms.

user of such materials should satisfy himself that they are suitable in the above respect for the duties to be imposed to them.

2.3 Responsibility for Selection and Assignment — The responsibility for the selection of appropriate materials and systems lies with the manufacturer of the electrotechnical product. Only experience or adequate appropriate tests provide bases for assigning rational temperature limits for the insulation. Service experience is an important basis for the selection of materials and systems. Where new materials and systems are involved, acceptable tests are the basis for this selection (*see also* **4**).

3. THERMAL EVALUATION OF INSULATING MATERIALS

3.1 Many insulating materials of the same generic type are available in a number of variants of different thermal endurance capability. Therefore, the generic chemical designation of insulating materials is inadequate to characterize their thermal capabilities.

When applying materials for the insulation of electrotechnical products their individual thermal endurance characteristics may be affected by the way in which they are combined with others. The thermal capability of materials used for insulation of electrotechnical products also depends strongly on the special functions they will be called upon to fulfil.

In respect of the use in electrotechnical products, material evaluation serves two purposes: one is to obtain evaluation of a material to be used as a component in an electrical insulation system, the other is to evaluate a material to be used alone or as part of a simple combination to become an insulation system.

Generally, tests and experience are recognized as the acceptable basis for the thermal evaluation of insulating materials.

When the basis of experience is used, care is required to ensure that it is relevant. Yet it may often be valid to translate experience from one type of application to another. Methods appropriate for establishing the relevance of service experience are to be prepared.

Considerable progress has been made in the development of tests to evaluate materials. Reference should be made to the following standards:

IS : 8504 Guide for the determination of thermal endurance properties of electrical insulating materials:

IS : 8504 (Part 1)-1977 General procedures for the determination of thermal endurance properties, temperature indices and thermal endurance profiles

IS : 8504 (Part 2)-1983 List of materials and available test

IS : 8504 (Part 3) Statistical methods (*under preparation*)

IS : 8504 (Part 4) Instructions for calculating the thermal endurance profile (*under preparation*)

NOTE — New parts and amendments of the test specifications are in preparation. While considering complete specification, following definitions may be helpful:

a) *Thermal Endurance Graph* (*Arrhanius Graph*) — A graph in which the logarithm of time to reach a specified end point in a thermal endurance test is plotted versus the reciprocal thermodynamic (absolute) test temperature.

b) *Temperature Index* (*TI*) — The number corresponding to the temperature in °C derived from the thermal endurance relationship at a given time, normally 20 000 h.

c) *Relative Temperature Index* (*RTI*) — The temperature index of the material whose thermal endurance characteristics are unknown obtained from the time which corresponds to the known temperature index of a reference material when both are subjected to the same ageing and diagnostic procedure in a comparative test.

d) *Halving Interval* (*HIC*) — The number corresponding to the temperature interval in degrees celsius which expresses the halving of the time-to-end-point taken at the temperature of the TI or the RTI.

Different temperature indices and halving intervals for a single material may be obtained when different types of test criteria and end points — electrical, mechanical, etc — are used for the thermal endurance graph. Different temperature indices may indicate differing thermal capabilities and so determine the way the material is used and the function it may perform.

Tests on standard specimens may give results different from those which might be obtained from tests on the material in the form in which it is to be used. Thus, the results of insulation systems tests may be used to verify the suitability of the material for the application concerned.

4. THERMAL EVALUATION OF INSULATION SYSTEMS

4.1 The preferred basis for assessing the thermal endurance of an insulation system is relevant service experience. Where this experience does not exist, appropriately designed functional tests should be carried out. For this purpose a service proven system is needed to be used as a reference insulation system.

A reference insulation system should be described by the responsible equipment Technical Committee on the basis of service experience. The Committee should establish guidelines for the particular equipment to explain how an insulalion system with a record of service experience can be used as a reference. The use of such guidelines should enable the Committee to replace previous definitions of classes which were based on material descriptions.

For evaluating new insulation systems by comparison with reference systems, specific test procedures will be developed by Equipment Technical Committees, when these Committees deem standardization to be necessary.

Very few test procedures have so far been standardized and, in general, it is the responsibility of the equipment manufacturer to devise and execute suitable tests where standardized tests do not exist.

Before designing suitable tests, reference should be made to IS : 11184 (Part 1)-1984*.

More detailed recommendations concerning the design of thermal evaluation test procedures are given in IS : 11182 (Part 2)-1984†.

In selecting the individual components of an insulation system, some guidance may be obtained from the thermal evaluation of the materials alone (*see* **3**).

For a material to be recognized as suitable for use in a particular insulation system, it is sufficient to demonstrate satisfactory performance by appropriate system tests or by experience, irrespective of the thermal endurance of the material by itself.

For very simple and simply stressed insulation systems, the equipment Technical Committee may decide whether functional tests according to IS : 11182 (Part 1)-1984‡ are required or whether the simpler case of evaluation from materials thermal endurance data according to IS : 8504 would produce satisfactory results. If it is necessary to evaluate the suitability of insulating materials for application in electrotechnical products then comparative tests should he performed using service proven materials as reference.

*Guide for determination of insulation systems for electrical equipment: Part 1 Identification, evaluation and ageing mechanisms.

†Guide for determination of insulation systems for electrical equipment: Part 2 Thermal endurance test procedures.

‡Guide for determination of insulation systems for electrical equipment: Part 1 Identification, evaluation and ageing mechanisms.

For these cases, it is recommended that the Equipment Technical Committee provide information about service proven materials for specific applications. Alternatively, it should provide rules on how to evaluate relevant experience which could be used to classify materials.

As long as Equipment Technical Committee do not present standardized procedures suitable for comparative evaluation of insulating materials the responsibility to choose acceptable test procedures remains with the manufacturer of the product.

5. CLASSIFICATION

5.1 For the classification of electrotechnical products (*see* **2.2** in particular, **2.2.5** and **4**).

In the special case when an insulating material, simple combination, or an insulation system has been shown by test or from service experience to be capable of operating successfully at a particular temperature in a particular application it may be assigned the appropriate thermal class selected from the list in **2.2.**

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